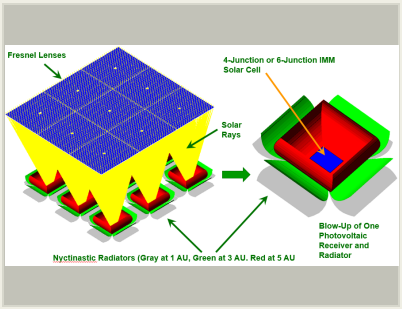
Small Business Innovation Research/Small Business Tech Transfer

25x Space Fresnel Lens Concentrator Using 4(+) Junction IMM Solar Cells and Nyctinastic Graphene Radiators to Mitigate LILT Effects for Outer Planet Missions, Phase I

Completed Technology Project (2017 - 2018)

Project Introduction

The innovation is a unique solar array for powering NASA's deep space missions without the low-intensity, low-temperature (LILT) problems of conventional arrays. The new array uses a robust, ultra-light, color-mixing Fresnel lens to point-focus sunlight at a 25X concentration ratio onto the most advanced 4-junction and 6-junction inverted metamorphic (IMM) photovoltaic cells. Waste heat from the cells is dissipated to space by a bio-inspired nyctinastic graphene radiator. The radiator passively folds up around the cell, like a flower at night, to reduce the drastic temperature drop in deep space, due to the reduction in solar irradiance at large distances from the sun. The 25X concentration and the high-optical-efficiency lens eliminate the low-intensity (LI) problem by maintaining an irradiance on the cell of nearly one AM0 sun at 5 AU distance from the sun. The nyctinastic radiator mitigates the low-temperature (LT) problem of conventional arrays by maintaining the cell temperature at about -100 C instead of the typical -140 C at 5 AU. This warmer cell temperature minimizes changes in band gaps for the 4 junctions or 6 junctions in the cell, thereby maintaining better current matching for the series-connected junctions. The performance metrics of the new array are unprecedented. The expensive solar cells are reduced in area and cost by 95% compared to conventional one-sun cells. The cells can be heavily shielded front and back from space radiation at very low mass penalty, due to the small cell size. The overall specific power of the lens + cell assembly + radiator is more than 1,400 W/kg for a heavily shielded cell, about 3X better than for a one-sun cell with the same shielding. The feasibility of the new array technology will be proven in Phase I by the small business (Mark O'Neill, LLC), the research institution (University of Connecticut), and the IMM cell firm (SolAero). In Phase II, fully functional hardware will be developed and delivered.



25x Space Fresnel Lens Concentrator Using 4(+) Junction IMM Solar Cells and Nyctinastic Graphene Radiators to Mitigate LILT Effects for Outer Planet Missions, Phase I Briefing Chart Image

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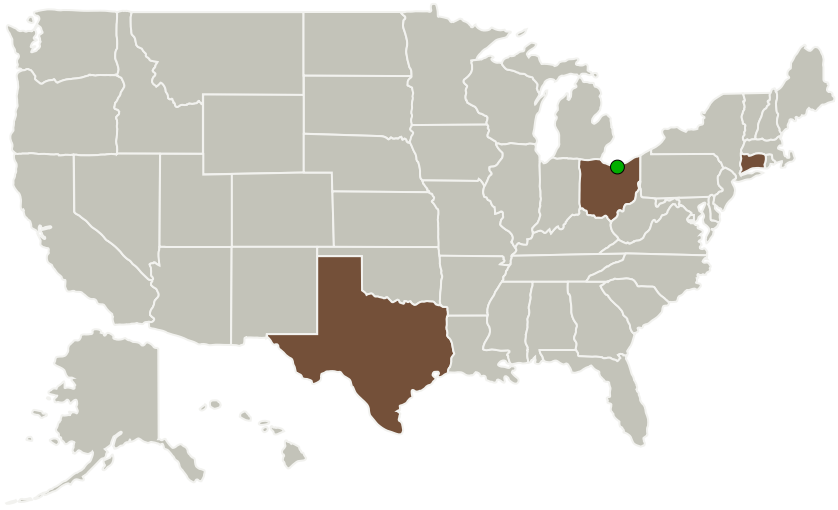
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Mark O'Neill, LLC	Lead Organization	Industry	Keller, Texas
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
University of Connecticut	Supporting Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	Storrs, Connecticut

Primary U.S. Work Locations	
Connecticut	Ohio
Texas	

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Mark O'Neill, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

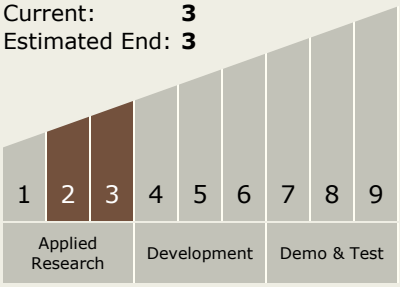
Carlos Torrez

Principal Investigator:

Mark O'neill

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Completed Technology Project (2017 - 2018)

Project Transitions

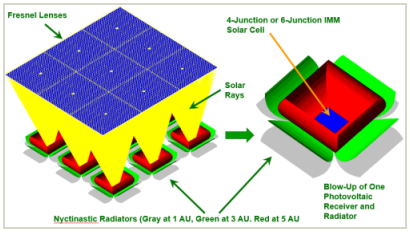
June 2017: Project Start

June 2018: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140850)*

Images



Briefing Chart Image
25x Space Fresnel Lens Concentrator Using 4(+) Junction IMM Solar Cells and Nyctinastic Graphene Radiators to Mitigate LILT Effects for Outer Planet Missions, Phase I Briefing Chart Image *(https://techport.nasa.gov/image/128215)*

Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.1 Photovoltaic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System